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J. W. BONGBERG

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project	Date	Author

TITLE

LOSS PREVENTION STUDIES

BLACK'S MOUNTAIN EXPERIMENTAL FOREST

SEASON 1938

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May 12, 1939

LOSS PREVENTION STUDIES

BLACK'S MOUNTAIN EXPERIMENTAL FOREST

SEASON 1938

APPROVED BY:

J. M. MILLER
Senior Entomologist, In Charge

SUBMITTED BY:

J. W. BONGBERG
Junior Entomologist

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ABSTRACT

A tentative method whereby green trees are segregated into risk groups has recently been developed by members of the Berkeley Forest Insect Laboratory. In cooperation with the California Forest and Range Experiment Station, experiments are being set up at the Black's Mountain Experimental Forest to test the application of the risk ratings and determine the effects of that application.

Crown characters are being used as indicators of tree health, a basis in rating tree risk. Measurements of crown characters have shown that:

1. Crown density is directly correlated with the needle complement of twigs holding needles. Thin crowned trees are believed to be in poor health and are rated as high risk.

2. Needles have been found to vary considerably in length. There is as much as 3 inches difference between short and long needles. Short needles are believed to represent symptoms of poor health. Short needled trees are generally rated as high risk.

Green trees are being indelibly marked into one of four risk groups for the following purposes:

1. To test the mortality occurrence within risk groups
2. To follow the rate of risk change in individual trees.
3. To determine what effect the removal of high risk trees from the stand has on subsequent insect loss.

Preliminary observations have shown that:

1. Insect loss has occurred predominantly in trees previously classed as high risk. There has been nearly 45 times as much loss in high risk trees as in low risk trees.

2. Critical crown characters have been recorded on approximately 1900 green trees. Periodic examinations will definitely show the rate of change in individual trees and the period of time in which the risk ratings will remain valid.

3. For the first 14 month period following logging operations in which high risk trees have been removed from the stand, there has been an 86.5% reduction in insect caused loss on cut areas.

Trees have been permanently marked on plots subjected to four separate methods of cutting. The effects of each cutting practice on tree risk and loss reduction will be determined by periodic examinations.

LOSS PREVENTION STUDIES
BLACK'S MOUNTAIN EXPERIMENTAL FOREST

Season of 1938

INTRODUCTION

In order to carry out the sustained yield experiments in pine (2) on the Black's Mountain Experimental Forest, the cooperation of the California Forest and Range Experiment Station and the U. S. Bureau of Entomology and Plant Quarantine was necessary because of the importance of entomological factors in these stands. It was realized that the various tests of sustained yield would be impossible unless adequate control measures could be developed to reduce the continuing insect loss on the area.

During the winter of 1934, a control program was undertaken in an attempt to reduce the high insect loss level on a part of the Experimental Forest. The effects of the direct control measures in reducing insect loss were not lasting and it was not considered economically feasible to control infestations in this area by this method.

Since 1934, various research activities conducted by members of the Berkeley Forest Insect Laboratory have shown that the majority of the trees in each season's loss are made up of discernable types of trees. It was considered probable that these tree types could be detected prior to attack by tree killing insects and marked for removal in a highly selective logging program. This logging program would completely utilize the values represented in the trees making up the majority of the seasonal loss. At the same time it would remove from the stand the preferred host material that is involved in the build up of barkbeetle populations. If a reduction of the yearly insect loss could be secured by this action, it would then permit the test and practice of sustained yield forestry.

OBJECTIVES OF THE BUREAU PROGRAM

The objectives of the Bureau of Entomology and Plant Quarantine in the program at Black's Mountain are to determine:

1. Can high risk trees be detected in the green stand with a high degree of accuracy?

2. Will the removal of high risk trees in a sanitation-salvage cut materially reduce subsequent loss resulting from endemic infestations?

3. Will the removal of high risk trees from the stand help prevent the occurrence of conditions contributing to the build up of heavy western pine beetle populations?

In order to reach these objectives it was first found necessary to define the tree types according to degrees of risk of insect attack. Secondly, wherever possible, it was necessary to measure the differences in the characters used in defining risk. Thirdly, it was necessary to set up experiments to test the application of the risk ratings and determine the effects of that application.

DEFINITION OF RISK RATINGS

A tentative method for segregating trees into risk groups has recently been developed by members of the Berkeley Forest Insect Laboratory. These ratings attempt to evaluate the relative risk of individual trees to insect attack. The present risk ratings make use only of the apparent health of the crown as evidenced in the foliage, twigs, or branches.

Accidental injuries, such as lightning or mechanical damage, affecting the immediate risk of trees are not included in the risk description. An appraisal of the effect of the mechanical injury on tree risk must be made independently of other characters.

The definition of the risk ratings presented herein are those given by Dr. K. A. Salman in a Station Memorandum dated May 5, 1938. (4) As suggested by Dr. Salman, a few modifications of the risk definitions have been made, all of which are in accordance with the present views of members of the Berkeley Forest Insect Laboratory.

"In the following description a certain order is followed. First the degree of tree health represented by the class is given. Second is a general statement of a broad impression of the crown condition of the group. Third are statements describing symptoms connected with degree of risk, each of which may be considered independently.

"Group 1

VERY GOOD HEALTH — LOW RISK

Full foliaged, healthy appearing crowns.
Foliage of healthy appearance, needles usually long and coarse, color good dark green.
Practically all twigs with normal foliage complement, no weakened portions of crown.

"Group 2

GOOD TO FAIR — MODERATE RISK

Fair to moderately healthy crowns, imperfect in spots.
Foliage mostly healthy, needle length average or better, color fair to good.
Some twigs or branches lacking foliage complement, few small weakened portions of crown.

"Group 3

FAIR TO POOR HEALTH — HIGH RISK

Crowns of fair to poor health, somewhat ragged or thin in parts
Foliage in parts of crown thin, bunchy or unhealthy, needles average to shorter than average, color fair to poor.
Some to many twigs lacking foliage, some branches fading or dead.

"Group 4

VERY POOR HEALTH — VERY HIGH RISK

Crowns of very poor health, ragged or thin, often showing evidences of active infestations
Foliage thin or bunchy. Needles short or sparse. Color poor.
Twigs and branches dead or dying. Large portions of crown weakened. Active top-killing or partial infestations often present.

"There are certain defects of trees which are not considered to enter into tree risk. Apparently they are not connected with the health or lack of health of individual trees. These defects are as follows:

"Stag top: An old bare spike, the result of an old top-killing infestation from which the tree has recovered. If other parts of the crown are vigorous and the spike is not connected with progressive infestations or other evidences of deterioration, it should be ignored. Often, however, weakening and evidence of progressive infestations are associated with stag tops. In such cases, that evidence is utilized in assigning a risk rating.

"Mule tail foliage: In some trees foliage has a distinctly bunchy appearance though the needles are long. This condition is due to a peculiar development of the branches and apparently is a normal character of a certain strain or type of pine tree. Other things being equal, it should be ignored.

"Off color due to cold: In certain years and locations, needles are browned due to the effects of low temperatures. This browning of itself does not seem to indicate poor health. If severe, or if it affects entire tops of cambium, it may have a considerable effect on tree risk. However, light, local, or generalized browning of foliage should be ignored.

"Cone fade: Often, in seed years, needles behind the cones die and fade. Apparently this fading has no relation to tree health.

"Natural shading out of branches: On most trees in a fairly closed canopy the lower branches lose their foliage and die. This must be differentiated from the dying of twigs and branches in the upper, undhaded parts of the crown which are definite indications of poor health. Natural shading out of branches does not indicate a weakness.

"In stands and in individual trees there apparently are no clearly marked steps in the change, over time, from a low risk to a high risk condition. Those changes are marked by the appearance of no definite single character that can be used in all trees. Usually several or different evidences of deterioration develop in different trees. Some appear to be more particularly concerned with the early stages of deterioration while others may be more closely connected with the later stages.

"There seems to be, in individual trees and depending on effective factors, periods of retarded or increased rates of change in the progression leading to high risk and death. In different areas the rate of change is different, being more rapid in the environments that are more unfavorable to tree health. In some trees, particularly those in which symptoms of risk concern only a small portion of the crown or bole, there may be reverses in the progression and recovery is possible."

MEASUREMENTS OF CHARACTERS USED IN DEFINING RISK

During the season of 1938, studies were begun to determine the possibility of measuring crown characters used in defining tree risk. Tentative results drawn from these preliminary investigations show that differences in crown characters do exist and some can be measured.

1. Crown Density: The needle complement of twigs holding needles has been found to vary considerably between dense crowned and thin crowned trees, or between parts of the crown on the same tree. Tentative conclusions drawn from a count of 17,600 needle fascicles on 158 twigs from six separate trees shows that:

    a. The needle complement of a thin crown averages 48 fascicles per twig.
    b. The needle complement of a medium to dense crown averages 121 needle fascicles per twig.

    Crown density appears to be dependent on the needle complement of twigs holding needle fascicles.

2. Needle Length: A measurement of 17,600 needle fascicles from six trees in which needle length had ben indicated as short, medium or long, shows that definite differences in needle length occur. Tentative conclusions drawn from the above measurements indicate:

    a. Needles indicated as being short average 4.2" in length.
    b. Needles indicated as being medium average 5.2" in length.
    c. Needles indicated as being long average 7.1" in length.

3. The extent of injuries, such as dead twigs, dead branches, or top-killing can be judged without measurements being taken. The combined characters of crown density, needle length, twig and branch injury are apparently indications of tree health and are used in defining tree risk.

TEST OF RISK RATINGS AT BLACK'S MOUNTAIN

1. Risk Marking

A check of the accuracy of the risk ratings is secured by classifying tree characters into risk groups and following the subsequent losses on undisturbed areas. The mortality occurring within each of the four risk groups should indicate the accuracy of the risk ratings. These marked trees will continue to serve as basic material for this study of the test of risk ratings. Preliminary observations on loss occurrence subsequent to marking have shown that the mortality rate in high risk trees has been nearly 48 times that in low risk trees (1).

During 1938, all of the trees on three compartments, four 20 acre plots, and approximately 10 acres in each of eight scattered compartments were given risk ratings. It is advantageous to have all of the trees on as much of the area as possible marked into risk groups. A larger sample of trees where risk ratings have been applied but no detailed studies attempted will furnish loss records supplementing those secured on study plots.

Progress of the 1938 risk marking along with the areas classified during 1937 is shown on the appended map, figure 1. The proportion of the total green stand distributed into each of the four risk groups is given in table 1.

Table 1.

Distribution of Green Stand by Risk Groups

Year of Marking	Timbered Acreage	Risk 1 (% Total) Trees	Risk 1 (% Total) Vol.	Risk 2 (% Total) Trees	Risk 2 (% Total) Vol.	Risk 3 (% Total) Trees	Risk 3 (% Total) Vol.	Risk 4 (% Total) Trees	Risk 4 (% Total) Vol.
1937	1044	71.8	61.3	18.1	24.4	5.7	8.0	4.4	6.3
1938	427	61.4	50.6	26.9	34.0	7.7	10.1	4.1	5.3
Total	1471								

2. Methods of Cutting

A test of the effectiveness of removing the high risk trees from the stand in a sanitation-salvage cutting program to reduce endemic insect loss and prevent occurrence of a build up of western pine beetle populations involves a comparison of losses subsequent to cutting on treated and untreated areas.

During 1937, the cutting program for the removal of high risk trees was limited to 243 acres. A comparison of subsequent insect losses on this 243 acres with a comparable uncut area of 140 acres has shown that a reduction of insect loss amounting to 86.5% was secured during the first 14 month period following cutting (1).

During 1938, the Experiment Station practiced sanitation-salvage cutting on three compartments, a total of 288 acres. In addition, three other types of cutting were practiced on 60 acres of plots. The plots were established by the Experiment Station to demonstrate the methods of cutting to be tested on the Experimental Forest. (3) Subsequent losses on these areas will be used to supplement existing data on the effectiveness of different methods of cutting in reducing insect losses and preventing a build up of barkbeetle populations.

Location of the plots in Block '38 and progress of the two years' cutting is shown on the accompanying map, figure 2. An inventory of the sanitation cutting to date is given in table 2.

Table 2.

Inventory of Sanitation-Salvage Cutting.

Year of Cutting	Comp't. Number	Timb'd Area	Inventory of Removal					
			Low Risk		High Risk		Total	
			Trees	Volume	Trees	Volume	Trees	Volume
1937	62-14	81.3	29	42,222	173	190,591	202	232,813
1937	66-10	94.8	76	123,373	116	151,377	192	273,750
1937	68-10	66.9	18	26,773	122	155,284	140	182,057
1938	60-14	79.0	-	-	215	210,026	215	210,026
1938	B25-1	113.7	1	736	278	297,722	279	298,458
1938	B27-4	95.7	-	-	356	367,418	356	367,418
Total		531.4	124	192,104	1,260	1,372,418	1,384	1,564,522

By having the trees on the set of experimental plots indelibly marked according to degrees of risk, it is possible to determine the effectiveness of each method of cutting in removing high risk trees and in addition, follow loss occurrence by risk groups in the reserve stand.

Plot 1. Modified Forest Service Cutting. All trees 18" d.b.h. and over classed either as high risk or as Dunning 4 or 7 are cut. All good risk trees of Dunning's classes 1, 2, 3, or 6 are left. All of Dunning's class 5 trees are cut. Class 5A, distinguished from class 5 by having long vigorous crowns, are left except those having one or two grade 1 butt logs. The reserve stand will not be cut for a period of 30 years. The removal of trees by risk groups under the Modified Forest Service Cutting is shown in table 3.

Table 3.

Modified Forest Service Cutting. 20 acres

		Trees	Volume	Volume/acre
CUTTING				
Low Risk (Group 1 and 2)		95	118,965	5,948
High Risk (Group 3 and 4)		39	43,676	2,183
	Total	134	162,641	8,132
RESERVE				
Low Risk (Group 1 and 2)		274	165,456	8,272
High Risk (Group 3 and 4)		6	1,650	82
	Total	280	167,106	8,355

The above table shows that 96.4% of the volume marked as high risk was removed in the cutting operation. Approximately 1% of the volume in the reserve stand is made up of high risk trees. Ordinarily the high risk element in the reserve is made up of unmerchantable trees which, in practice could be removed in hazard reduction activities.

Plot 2. Control Plot. This plot has been set aside to serve as a check against cutting practice on the four other plots. The distribution of the trees by risk groups is shown in table 4.

Table 4.

Control Plot. 20 acres

		Trees	Volume	Volume/acre
Low Risk (Group 1 and 2)		324	345,267	17,263
High Risk (Group 3 and 4)		58	89,992	4,499
	Total	382	435,259	21,763

Plot 3. Silvicultural Selection Cutting. This type of cutting is designed primarily to secure the establishment of reproduction. Trees classed as high risk will be cut first. When the volume of high risk trees does not amount to 2,500 BM per acre, additional trees of low risk and high value will be added to make up a net cut of 2,500 feet. Future salvage cuts can be made in a similar manner when the volume of high risk trees again approaches 2,500 feet. Following salvage cutting, a heavy cut will be made where reproduction is satisfactorily established. Where brush dominates reproduction, or where reproduction is not well established, a series of light cuts will be made. These cuts will be timed when seed crops are ripe in order to make conditions favorable for securing and liberating reproduction. After a series of cuts over a 10-12 year period, the residual stand will approximate that of the Standard Forest Service Cut. The removal of trees, by risk groups, under the first sanitation-salvage cut is shown in table 5.

Table 5.

Silvicultural Selection Plot. 20 acres.

		Trees	Volume	Volume/acre
	CUTTING			
Low Risk	(Group 1 and 2)	23	22,564	1,128
High Risk	(Group 3 and 4)	35	33,081	1,654
	Total	58	55,645	2,782
	RESERVE			
Low Risk	(Group 1 and 2)	436	318,517	15,926
High Risk	(Group 3 and 4)	-	-	-
	Total	436	318,517	15,926

Plot 4. Standard Forest Service Cutting. Approximately 80% of the total green volume is removed from the stand under the Standard Forest Service cutting. The reserve stand is made up primarily of trees in Dunning's class 1, 2 and 6. In addition, the best trees in class 3 and 4 are left. The majority of the trees in class 4, 5 and 7 are cut. No additional cutting will be done for 60 years. The removal of trees, by risk groups, under Standard Forest Service Cutting is shown in table 6.

Table 6.

Standard Forest Service Cutting

		Trees	Volume	Volume/acre
CUTTING				
Low Risk (Group 1 and 2)		223	285.676	14.283
High Risk (Group 3 and 4)		44	54.590	2.730
	Total	267	340.266	17.013
RESERVE				
Low Risk (Group 1 and 2)		203	110.947	5.547
High Risk (Group 3 and 4)		8	2.223	111
	Total	211	113.170	5.658

The above table shows that 96.1% of the volume marked as high risk was removed in the cutting operation. Approximately 2% of the volume in the reserve stand is made up of high risk trees.

Plot 5. Sanitation-Salvage Cutting. This method of cutting precedes the series of heavy cuts in the Silvicultural Selection treatment. The plot was established because it was considered advisable to compare the Sanitation-Salvage cutting with the other above mentioned methods on areas of comparable conditions. All high risk trees were removed from the stand during 1937. Additional cutting will be made only when the volume of high risk trees approaches 2.500 BM per acre.

3. Rate of Risk Change

All of the reserve trees on the set of 5 plots are permanently marked with metal tags. On this series of trees, an attempt is being made to determine the rate of risk change for each individual tree within the four risk groups. Detailed crown characters were recorded on all trees to remain in the reserve stand prior to the cutting operations, then after logging, any injuries to the trees as a result of logging activities were noted. During 1939, these trees will be re-examined to determine the effect of cutting on tree risk. Thereafter, examinations will be made periodically to determine the rate of deterioration or recovery of each individual tree.

The critical crown characters were recorded on all merchantable trees in two 5 acre plots established in other areas on the Experimental Forest to determine the rate of risk change for individual trees. The risk group distribution of the total number of trees on the 100 acres of plots which will be studied in this manner are as follows:

Risk Group	1	1,274 trees
" "	2	516 "
" "	3	79 "
" "	4	32 "
Total		1,901

PLANS FOR CONTINUING WORK DURING 1939

The majority of the work at Black's Mountain during 1939 will be directed toward a refinement of the risk ratings applied to the green stand.

Risk ratings will be given all trees on areas selected for cutting in advance of the cutting program. In addition, the trees on the remaining unmarked natural areas will be given risk ratings.

A sample of immediate risk conditions will be made on as many compartments showing high average loss records as possible. This information will aid the Experiment Station personnel to select areas for immediate cutting.

A re-classification of crown characters on the numbered series of trees on study plots will furnish data as to the rate of risk change in individual trees. All leave trees on the series of plots to be established by the Experiment Station during 1939 will be studied for rate of risk change. In addition, plots will be established in each of the 5 natural areas and in other areas of better site conditions for similar studies.

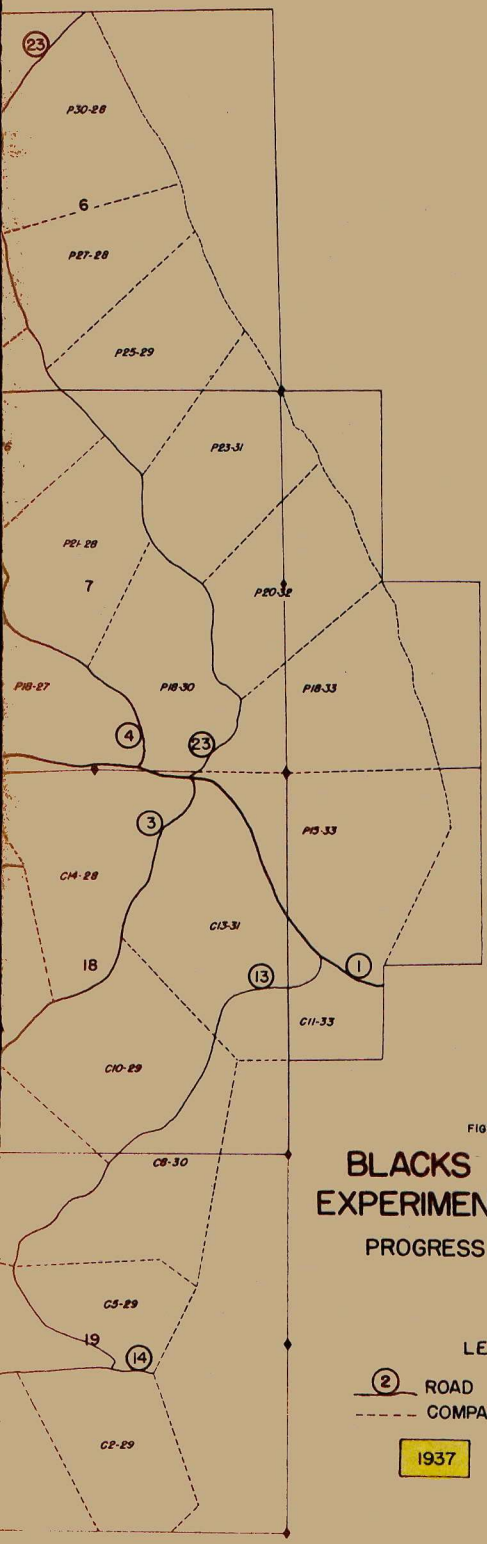


FIGURE 1

BLACKS MOUNTAIN EXPERIMENTAL FOREST

PROGRESS OF MARKING

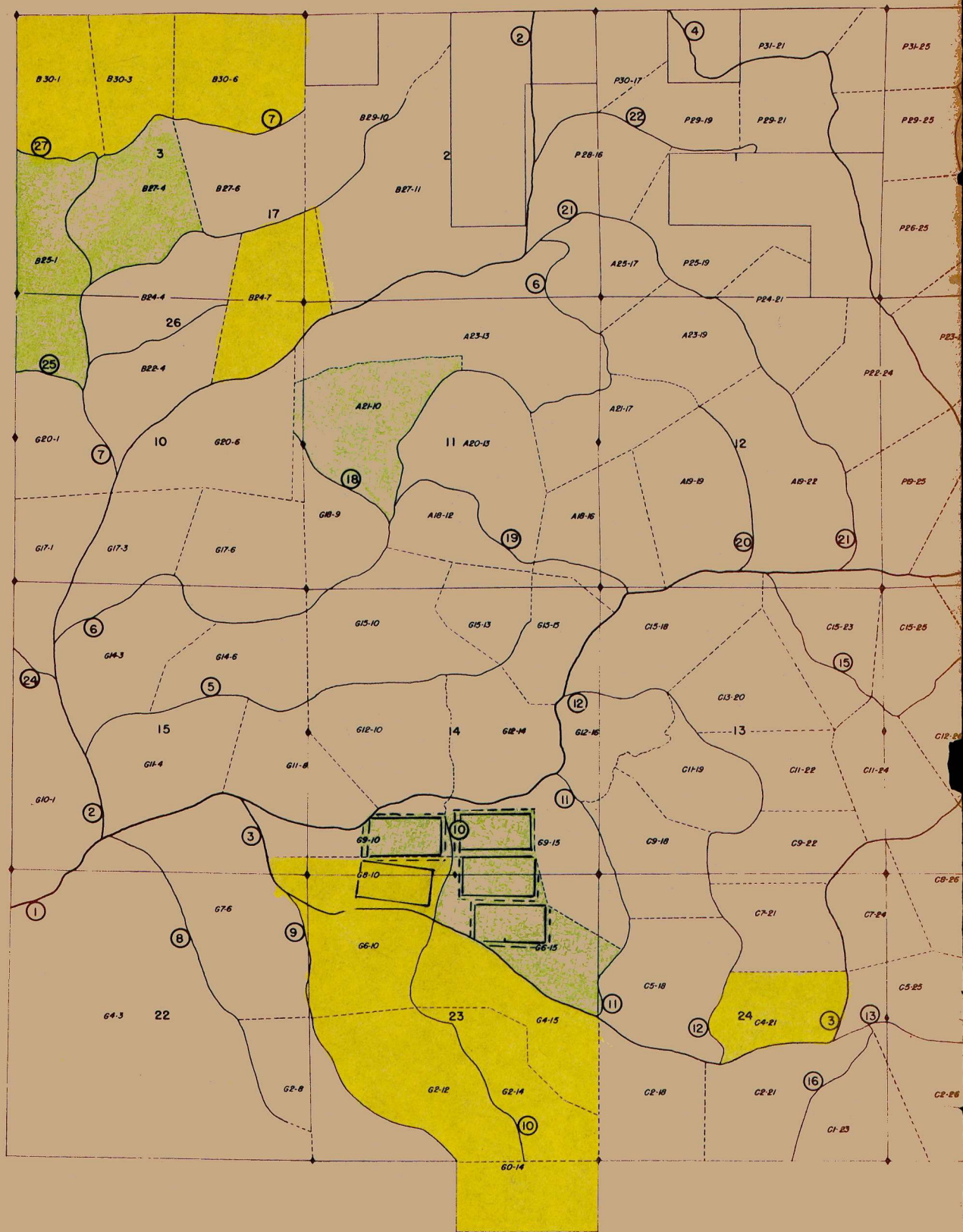
LEGEND

(2) ROAD

----- COMPARTMENT BOUNDARY

1937

1938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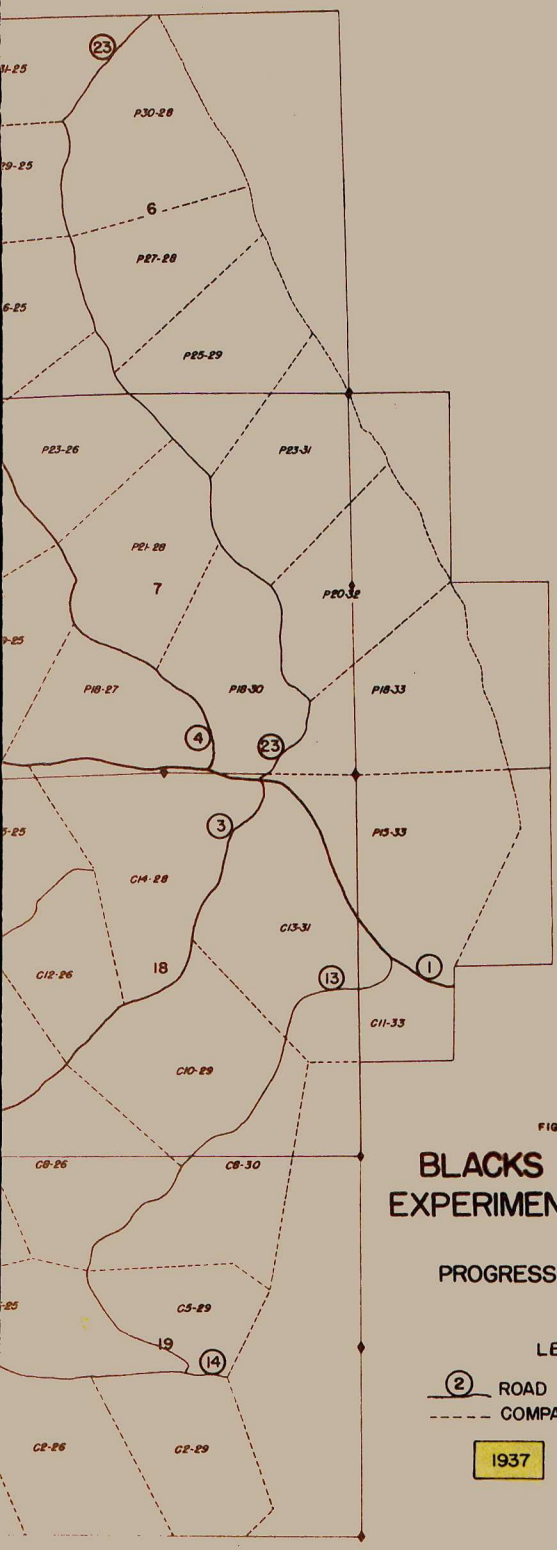


FIGURE 2

BLACKS MOUNTAIN EXPERIMENTAL FOREST

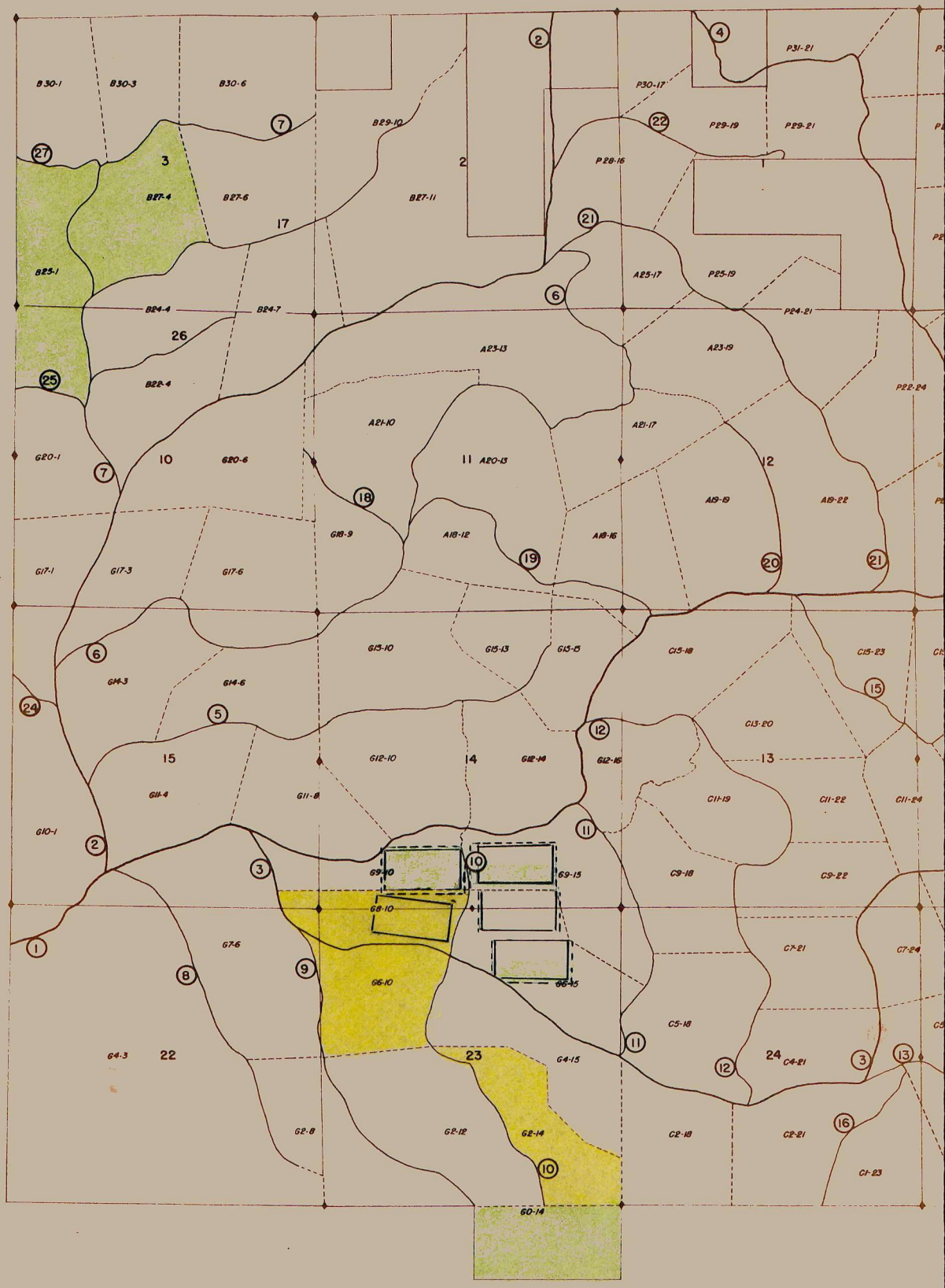
PROGRESS OF CUTTING

LEGEND

(2) ROAD

----- COMPARTMENT BOUNDARY

1937 1938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C1-23
G0-14

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